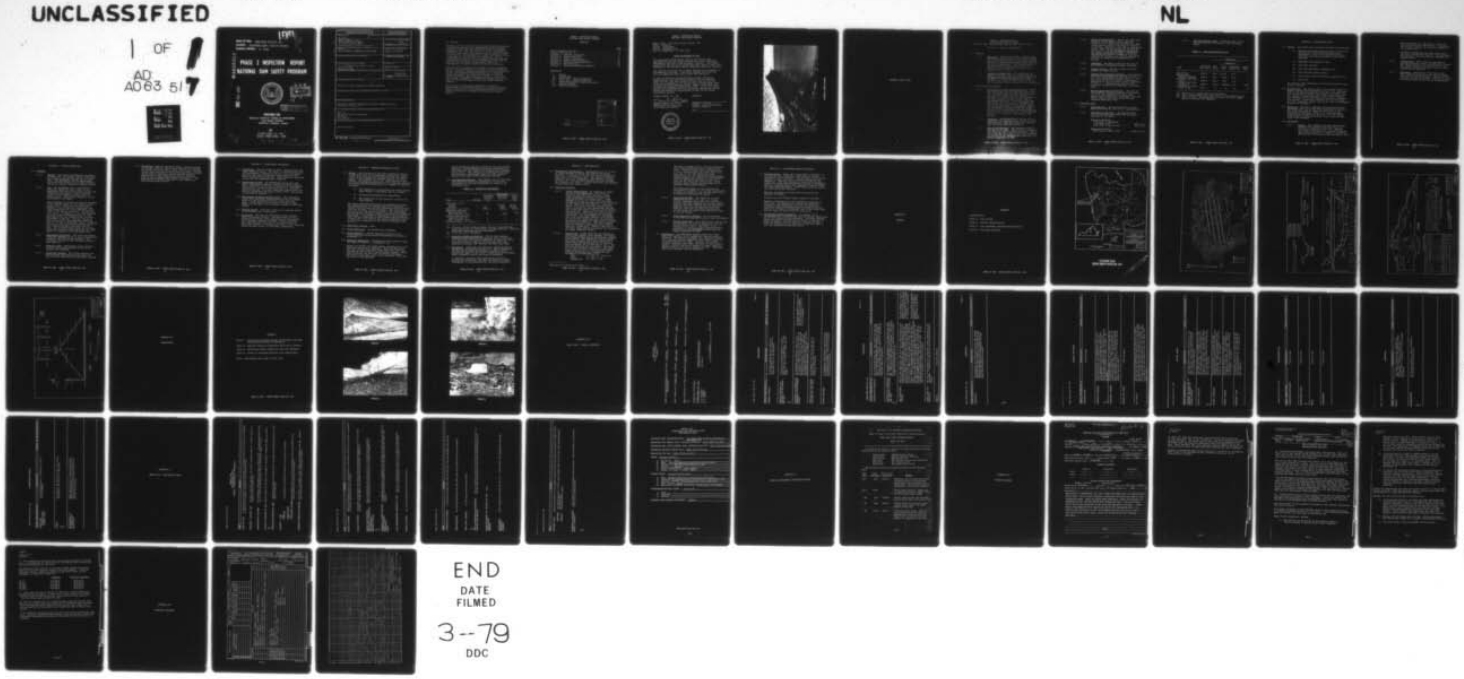
AD-A063 517 BAKER (MICHAEL) JR INC BEAVER PA F/G 13/2
NATIONAL DAM SAFETY PROGRAM. LOWER NORTH RIVER NUMBER 81C (INVE--ETC(U)
1978 M BAKER DACW65-78-D-0016
UNCLASSIFIED NL

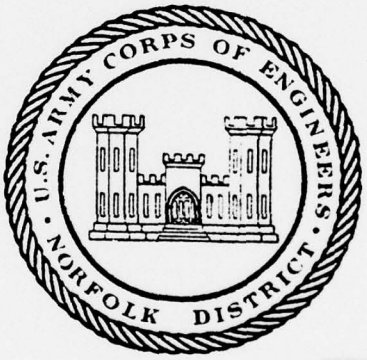
1 OF
AD
AD63 517



END
DATE
FILMED
3--79
DDC

Name Of Dam: LOWER NORTH RIVER NO. 81C
Location: ROCKINGHAM COUNTY, STATE OF VIRGINIA
Inventory Number: VA 16506

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

MICHAEL BAKER, JR., INC.
BEAVER, PENNSYLVANIA 15009

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: VA 16506	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: Phase I Inspection Report National Dam Safety Program. Lower North River No. 81C Number 81C (Inventory Number VA 16506) Rockinghman County, State of Virginia. Phase I Inspection Report.	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): ~~Michael Baker, Jr., Inc.~~ Michael Baker, III	8. CONTRACT OR GRANT NUMBER(s): DACW 65-78-D-0016
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Engineering District, Norfolk, 803 Front Street, Norfolk, VA 23510	12. REPORT DATE
	13. NUMBER OF PAGES: 57
14. MONITORING AGENCY NAME & ADDRESS *(If different from Controlling Office)*: Final rept. 1978	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

58 p.

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, If different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dams - VA
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

(See reverse side)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

420 795

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lower North River Dam No. 81C
State: Virginia
County: Rockingham
Stream: Skidmore Fork
Date of Inspection: 14 June 1978

BRIEF ASSESSMENT OF DAM

The Lower North River Dam No. 81C is an earthfill dam approximately 140 feet high and 1400 feet long, owned and operated by the City of Harrisonburg, Virginia. The visual inspections and review of engineering data, made in June 1978, indicate no serious deficiencies requiring emergency attention.

The spillway will pass the Probable Maximum Flood without an overtopping of the dam. Some clear seepage was noted but not of a magnitude that would affect dam stability.

It will be necessary to periodically inspect the clear seepage noted, for significant changes, and to regularly check the six inch hole located 30 feet from the toe for signs of enlargement or of flowing water, particularly after or during a large magnitude storm. Annual inspections and periodic maintenance should be continued. It is also recommended that reseeding and filling surface depressions on the downstream benches be accomplished as part of the annual maintenance program.

MICHAEL BAKER, JR., INC.

Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer

APPROVED:

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

Date: _____

OVERALL VIEW OF DAM

OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: LOWER NORTH RIVER NO. 81C ID# VA 16506

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams. The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Lower North River Dam No. 81C consists of an earthfill embankment approximately 140 feet high and 1400 feet long. Seepage control is provided by a bentonite core constructed into the dam, possibly because of the lack of impermeable borrows. The primary spillway and outlet works consist of a standard two-way fixed crest riser with a 42 inch reinforced concrete pipe as a discharge conduit. The discharge is controlled by the fixed crest and five slide gates which are operated by five hand wheel pedestals. The emergency spillway is a rock-cut, trapezoidal side channel.

1.2.2 Location: Lower North River Dam No. 81C is located on the Skidmore Fork of the Dry River approximately eight miles upstream from the Town of Rawley Springs, Virginia.

1.2.3 Size Classification: The maximum height of the dam is 140 feet. The reservoir volume to the spillway crest is 7367 acre-feet. Therefore, the dam is in the "large" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.2.4 Hazard Classification: Due to the eight mile distance to the Town of Rawley Springs, Virginia with a population of about 100, many lives could be lost in the event of failure of the dam. Therefore, this dam is considered in the "high" hazard category as defined by Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned by the City of Harrisonburg, Rockingham County, Virginia.

1.2.6 Purpose of Dam: The dam is used for water supply and flood control.

1.2.7 Design and Construction History: The existing facility was designed for the owner by the U.S. Soil Conservation Service (S.C.S.). The dam was built by W.C. English Incorporated beginning in July 1972 with a crest elevation of 2271.2. A second stage with a crest elevation of 2309.0 was completed in October 1975.

1.2.8 Normal Operational Procedures: The City of Harrisonburg, Virginia uses the stored water as a low flow supplement to their water supply creek located just downstream from the dam by opening the gates to provide the required additional water.

1.3 Pertinent Data

1.3.1 Drainage Area: The drainage area of Lower North River Dam No. 81C is 14.7 square miles.

1.3.2 Discharge at Dam Site: The maximum known flow at the dam site through the principal spillway is not known.

Principal Spillway:

Pool level at emergency spillway crest	356 c.f.s.
Pool level at top of dam	381 c.f.s.

Emergency Spillway:

Pool level at top of dam	24,653 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet M.S.L.	Reservoir Capacity Area acres	Reservoir Capacity Acre-feet	Reservoir Capacity Watershed inches (a)	Length feet
Top of dam	2309.0	189.5	10,357	13.2	-
Maximum pool, design surcharge	2298.7	165	8532	10.9	-
Emergency spillway crest	2291.4	151.5	7367	9.4	-
Principal spillway crest (b)	2272.5	118.5	4852(c)	6.2	5280
Streambed at centerline of dam	2170	0	0	0	0

(a) Based on 14.7 square miles of watershed.
(b) Top of conservation pool and bottom of flood control pool.
(c) Total storage, including 4500 acre-feet for water supply and 352 acre-feet for sediment.

SECTION 2 - ENGINEERING DATA

2.1 Design: The design data reviewed included the following:

1) As-built drawings indicating plan, elevations and sections of the dam and appurtenant structures. Logs of the test borings and test pits were also included in the as-built drawings.

2) Hydrologic and hydraulic data.

3) Soil test results.

4) 1972 Geologic Report (Appendix VI).

5) 1967 and 1972 Soils Reports.

6) 1972 Slope Stability Analyses (Appendix VII).

7) Work Plan.

All data has been submitted to the Norfolk District for future reference.

2.2 Construction: The dam was built in two stages by W. C. English Incorporated beginning in July 1972. Construction of the second stage was completed in October 1975. When construction started, plans were to build the dam to a height of about 100 feet. This height, however, was increased to 140 feet sometime during the construction period. Construction records were not available for this inspection report, but are on file in Washington, District of Columbia.

2.3 Operation: The dam is operated and maintained by the Shenandoah Valley Soil and Water Conservation District. The slide gate used to drain the reservoir is not periodically operated. There is no existing policy regarding the frequency of its use. The four higher slide gates are operated several times a year by the City of Harrisonburg.

2.4 Evaluation

2.4.1 Design: The Stability Analyses and as-built drawings were adequate for evaluating the structural stability of the dam. However, the as-built drawings show a greatly reduced impervious core section. About 75 percent of the cut-off trench was filled with Zone 2 and 3

materials which are described as silty and well graded gravels (GM and GW). Considering the as-built zoning, the Stability Analyses are conservative.

Foundation conditions were determined using the Soils and Geologic Reports. The hydrologic and hydraulic data provided was adequate for design review.

2.4.2 Construction: There were no construction records available, which explained the reasons for adding bentonite to the impervious core. The Geologic Report describes a lack of fine grained borrow material.

2.4.3 Operation: Operation of the lowest slide gate should be included in the annual inspection and maintenance program. Records of the operation of the four higher slide gates should be formally kept by the City of Harrisonburg.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The field investigation was made on 14 June 1978. No unusual weather conditions were experienced and the lake was at normal pool. The embankment and the appurtenant structure were found to be in good condition and do not require immediate remedial action.

3.1.2 Dam: The embankment was in good physical condition except for small areas on the downstream face which have sparse topsoil and vegetation (see Photos 1 and 3) and tire tracks on the downstream bench which are holding water. These areas should be filled with topsoil and seeded.

Clear seepage was present at various locations across the dam about 10 feet above the downstream bench. These were not measurable. However, a clear seep was located near the right downstream toe of the embankment very close to the outlet structure. Its flow was 0.75 g.p.m. In addition, a six inch diameter hole was found in the ground area 30 feet downstream from the downstream toe at about the middle of the dam. The hole may be an animal burrow but its appearance suggested that it was due to some other cause. Presently the area is dry, but waterstains around the area indicate possible drainage from the hole. All of these clear seeps and the hole should be inspected regularly to be sure that there is no piping of the embankment soil.

3.1.3 Appurtenant Structures: The inlet and outlet structures appeared to be in very good physical condition and functioning properly. The emergency spillway is also in good condition (see Photo 2).

3.1.4 Reservoir Area: The slopes in the reservoir area are well vegetated with little or no erosion and sloughing.

3.1.5 Downstream Channel: The outlet channels for the principal and emergency spillways are also in good condition with very minor erosion.

3.2 Evaluation: None of the above items is serious enough to warrant immediate repair since they do not threaten the integrity of the dam at normal pool level. Erosion control and vegetation of bare areas should be included in the annual inspection and maintenance program. Observation of the seepage areas and six inch hole require more frequent and diligent observation. The hole should be filled with sand or silt before an observation program starts.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The dam serves as both a flood control and water supply facility. The water is stored by the City of Harrisonburg, Virginia to use as a low flow supplement to their water collection point located a few miles downstream from the dam. Slide gates are operated to provide the supplementation required.

4.2 Maintenance of Dam: The Shenandoah Valley Soil and Water Conservation District conducts an annual maintenance inspection of the dam in conjunction with members from the U.S. Forest Service and the S.C.S. District Conservationists. The only inspection report since the dam was constructed was made in April 1978. The report is attached as Appendix V.

4.3 Maintenance of Operating Facilities: The Shenandoah Valley Soil and Water Conservation District is responsible for the maintenance of the risers and lift gates. These gates are relatively new and in good condition, but there are no formal records of lift gate checks.

4.4 Warning System: Presently, there is no warning system or evacuation plan in operation.

4.5 Evaluation: The dam was completed in 1975 and has a short maintenance history. The maintenance of the operating facilities since completion of construction are considered adequate; however, records should be kept regarding the operation of the gate which can drain the reservoir. An operation check of this facility should be made as part of the annual inspection.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: The elevation of the crest (elevation 2272.5) of the drop-inlet to the principal spillway was established at an elevation which would provide the conservation storage needed for sediment deposit and water supply. The capacity (356 c.f.s. with reservoir level at crest of emergency spillway) of the principal spillway was established by consideration of a number of factors including:

1) The capability of evacuating the flood storage space within a reasonable time (± 10 days).

2) Not passing damaging flows downstream.

3) The capability of the reservoir to store the flood waters.

The crest (elevation 2291.4) of the emergency spillway was established at the maximum elevation reached in routing the principal spillway hydrograph which resulted from the 100 year, 10 day rainstorm. The elevation of the top of the dam (elevation 2389.8) was established by the maximum elevation reached in passing the freeboard hydrograph. The freeboard hydrograph is that computed from rainfall comparable to the Probable Maximum Precipitation (P.M.P.) as used by the Corps of Engineers and is therefore comparable to the Probable Maximum Flood (P.M.F.)

5.2 Hydrologic Records: None

5.3 Flood Experience: No records were available.

5.4 Flood Potential: Design features of the dam were established by routing various hydrographs as noted in paragraph 5.1.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, paragraph 1.3.3.

Except for release for water supply, regulation of flow from the reservoir is automatic. Water rising above the crest of the drop-inlet flows into this inlet and through the dam in the 42 inch concrete conduit. Water also flows past the dam over the ungated emergency spillway in the event water in the reservoir rises over the crest of the spillway.

Outlet discharge capacity, reservoir area and storage capacity, and hydrograph and routing determinations were obtained from reports and computations furnished by the S.C.S. The routing of the emergency spillway and freeboard hydrographs began with the reservoir level at the crest of the principal spillway.

5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on reservoir performance in various hydrographs is shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrograph		
		Principal Spillway (a)	Emergency Spillway	Free-Board (b)
Peak flow, c.f.s.				
Inflow	-	-	10,084	25,127
Outflow	-	356	6093	25,034
Peak elev., ft. M.S.L.	-	2272.5	2298.7	2309.0
Emergency spillway				
Depth of flow, ft.	-	0	7.3	17.6
Avg. velocity, f.p.s.	-	0	13.5	-
Non-overflow section				
Depth of flow, ft.	-	-	-	-
Avg. velocity, f.p.s.	-	-	-	-
Tailwater elev., ft. M.S.L.	-	-	-	-

(a) 100 year, 10 day volume produces the most conservatively large indication of flood control storage required. Detailed discharge hydrograph was not determined.
(b) P.M.F. by C.O.E. standards.

5.7 Reservoir Emptying Potential: The 42 inch concrete reinforced pipe entering the upstream side of the riser at a low level will permit withdrawal of about 347 c.f.s. with the reservoir level at the spillway crest and essentially dewater the reservoir in about nine days.

5.8 Evaluation: Hydrologic and hydraulic determinations of the project as prepared by the S.C.S. appear reasonable. The dam and spillway are designed to pass a flood essentially equal to the P.M.F., which would be developed under standards used by the Corps of Engineers.

It should be indicated that conclusions pertain to present day conditions, and that the effect of future development on the hydrology has not been considered.

SECTION 6 - DAM STABILITY

6.1 Foundations and Abutments: Approximately 30 to 50 feet of coarse grained alluvium with cobbles and gravel blankets the bedrock in the 900 feet wide floodplain at this site. Red and gray, hard, fine grained sandstone underlies the soil overburden. The abutments consist of hard, red, fine grained sandstone and red siltstone with shallow soil cover. A minor fault zone was reported at dam centerline Station 6+20[1].

6.2 Stability Analysis

6.2.1 Visual Observations: No evidence of instability in the embankment, cut slopes or concrete structures was observed. Minor clear seepage was noticed just above the downstream bench in several areas. Clear seepage (0.75 g.p.m.) flows from the downstream toe of the dam near the outlet structure on the right side (see Photo 4). Approximately 0.75 g.p.m. of clear seepage outlets from a location 150 feet downstream from the toe on the left side in the old stream channel (see Photo 3). There are two other areas of non-measurable clear seepage near the downstream toe. The replacement of impermeable soil with silty gravel (GM-GW) in 75 percent of the cut-off trench may have increased the potential for seepage to short-circuit through the bentonite-clay core. The clear seepage does not indicate a potential hazard due to piping at normal pool. However, the flow at the clear seeps should be observed for increases at higher reservoir levels.

6.2.2 Design Data: Slope stability was checked in 1972 by the Swedish Circle Method, the Simplified Bishop Method and by the Navdocks Sliding Block Method. The embankment section chosen for these analyses had a crest elevation of 2308.0 feet and side slopes of two and one-half horizontal to one vertical (2.5:1). The section indicated two soil zones. The shell of the dam was shown adjacent to a core with slope ratios of 0.5:1. The following shear strength parameters were assumed for the foundation and embankment soils:

core . . . . . $\phi = 23°$, c = 700 p.s.f.
shell . . . . $\phi = 35°$, c = 0
foundation . . $\phi = 35°$, c = 0

---

[1]Stations are indicated on Plate 1.

The shear strength of the core was determined from consolidated undrained triaxial shear tests. Minimum safety factors computed were 1.32 for the upstream slope under full drawdown and 2.0 for the downstream slope. Computations for the downstream slope assumed steady seepage with a phreatic line extending from the emergency spillway elevation to a drain at the toe of the center core. Both minimum safety factors were obtained by the Navdocks Sliding Block Method.

The downstream slope was also checked for earthquake by adding a 0.15 seismic coefficient. A factor of safety of 1.48 was obtained using the Navdocks Sliding Block Method.

6.2.3 Operating Records: The report of a recent inspection by the S.C.S. and U.S. Forest Service indicates that there are no deteriorating conditions beyond minor surface erosion. However, the clear seepage was not mentioned. Highwater marks on the upstream slope show that the lake level has been approximately 10 feet above the present pool elevation with no serious damage.

6.2.4 Post-Construction Changes: No alternations to the dam were apparent since it was constructed.

6.2.5 Seismic Stability: Lower North River Dam No. 81C is located at the line of demarcation between Seismic Zones 1 and 2; therefore, it is considered to have no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams.

6.3 Evaluation: The embankment section chosen for these stability analyses is not compatible with the as-built drawings. The as-built drawings show additional zoning and a greatly reduced impervious core section (Zone 1) to which bentonite was added. However, the failure surfaces intersect less Zone 1 material in the as-built section, and the factors of safety for slope stability should increase over those computed in 1972. Therefore, additional analyses are not necessary.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: There are no detrimental findings, as a result of this inspection, from which an unsafe assessment can be rendered. The spillway is considered adequate to pass the P.M.F. without overtopping the embankment. No heavy seepage or slope failures were noted that would indicate potential piping or embankment failure, although minor clear seepage is present along the downstream embankment. Minor erosion exists on the face and should be corrected.

The data available was sufficient to evaluate the adequacy of design.

The dam will not require urgent remedial treatment.

Further investigation is not considered necessary at this time. The seeping area and the six inch hole located 30 feet downstream from the toe should be routinely observed during periods of higher reservoir levels for evidence of increased flow at the clear seep and any signs of flow at the six inch hole.

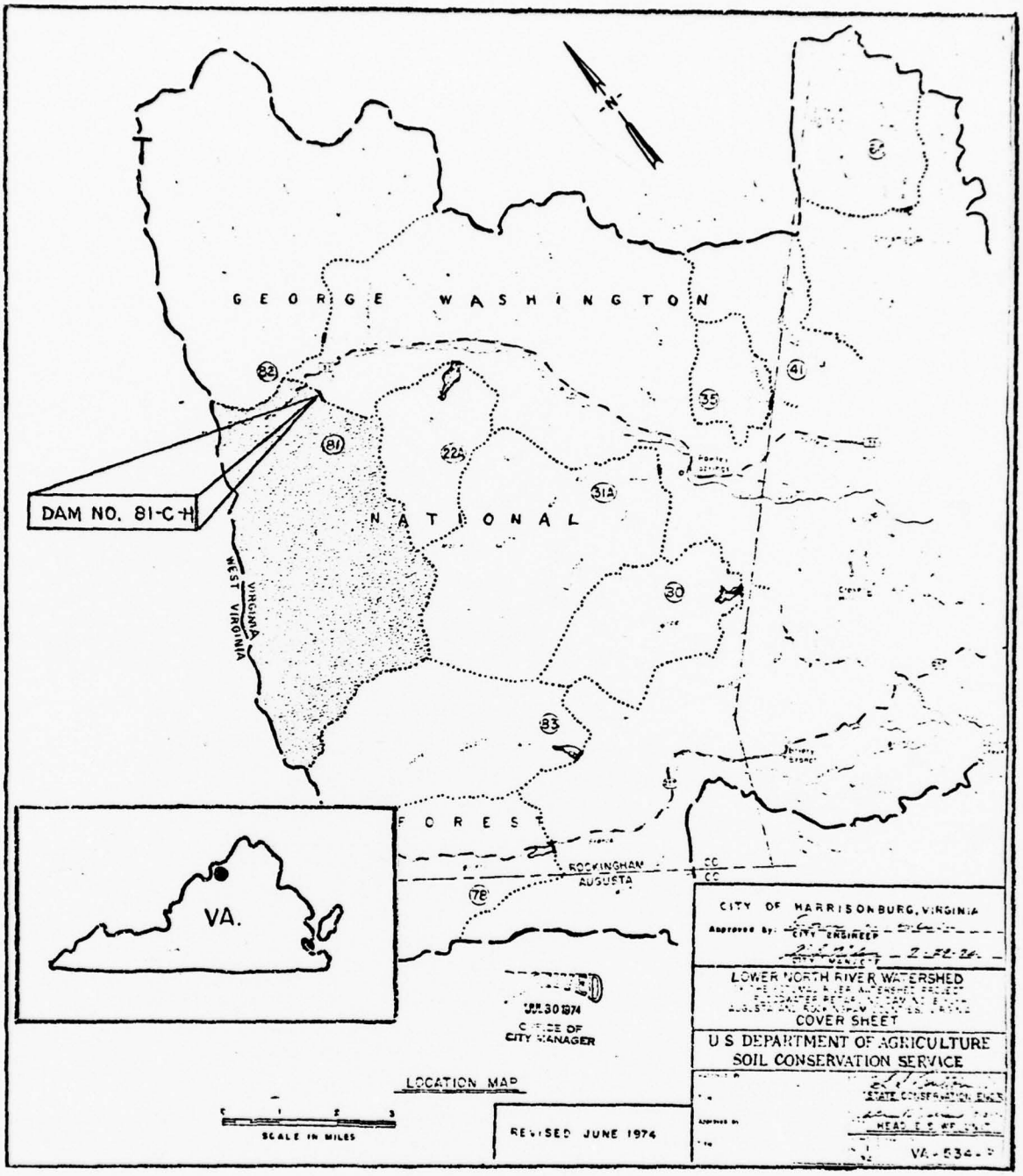
7.2 Recommended Remedial Measures: In summary, it is recommended that reseeding and filling surface depressions on the downstream face be completed. The clear seepage should be inspected regularly for signs of increase or muddy discharge. The six inch hole located 30 feet from the downstream face should be filled with sand or silt and inspected during high water.

APPENDIX I

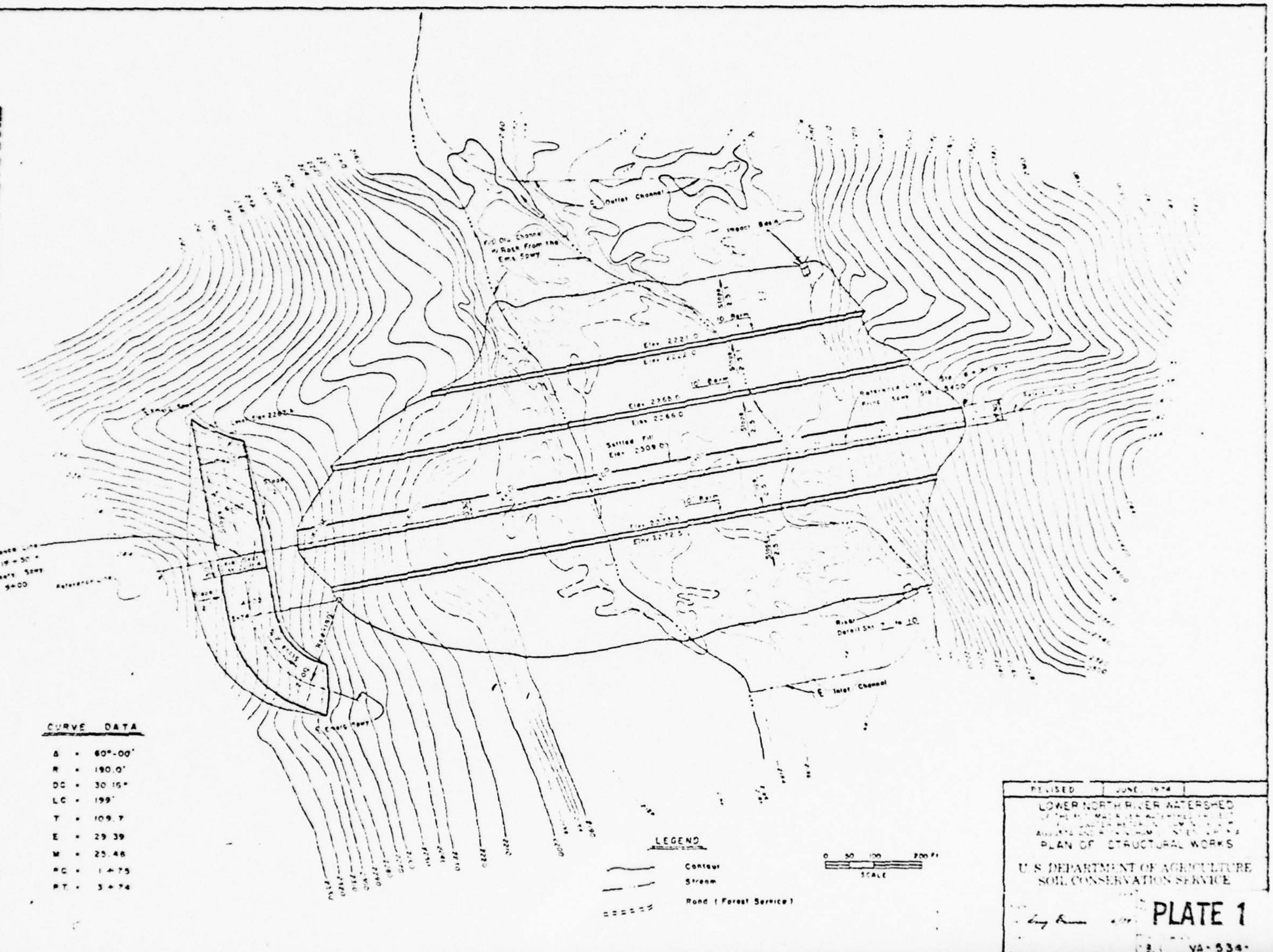
PLATES

CONTENTS

NAME OF DAM: LOWER NORTH RIVER NO. 81C



LOCATION PLAN
LOWER NORTH RIVER NO. 81C

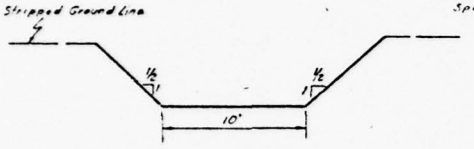


CONSTRUCTION DETAILS

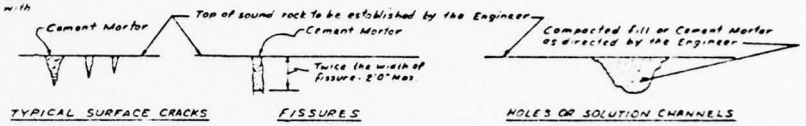
1 The excavation limits are approximate and will be adjusted in accordance with conditions encountered.

2 Rock exposed in the bottom of the cutoff trench shall be thoroughly cleaned and shall be inspected by the Engineer prior to the placement of compacted fill material.

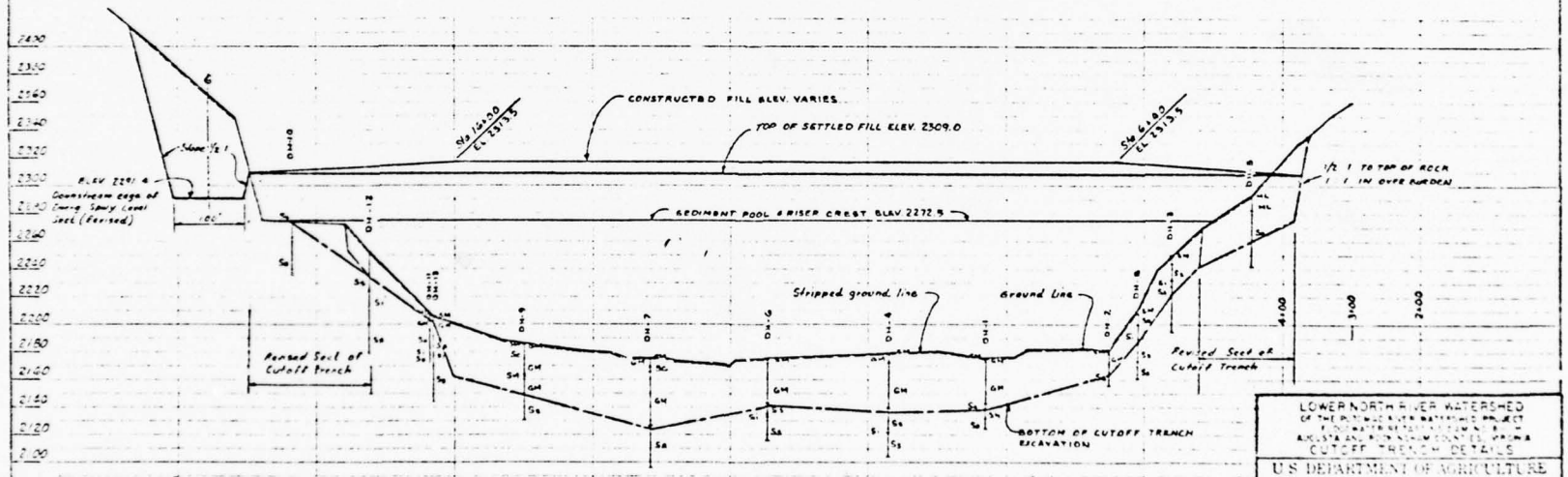
3 Surface cracks, fissures, holes and solution channels in the rock surface exposed by the cutoff trench excavation shall be treated in accordance with Spec 216.



TYP. SECT. OF REVISED CUTOFF TRENCH

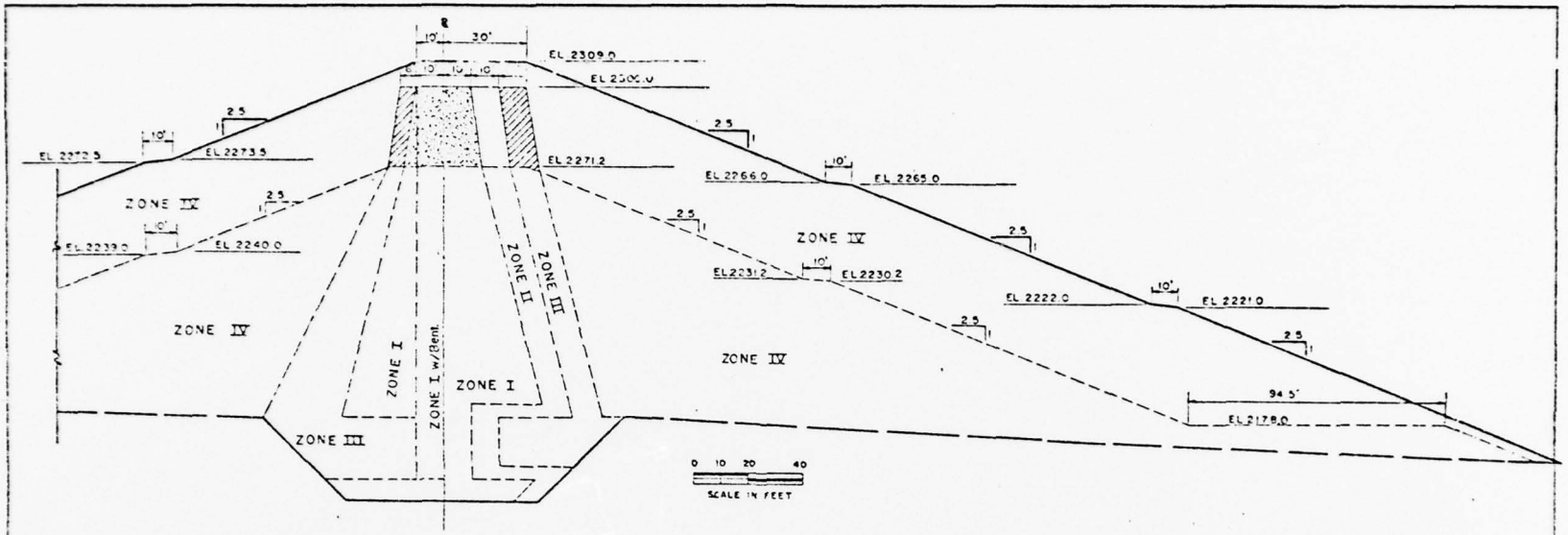


TYPICAL TREATMENT OF ROCK SURFACES



PROFILE ALONG REFERENCE LINE ℄ CUTOFF TRENCH (LOOKING DOWNSTREAM)

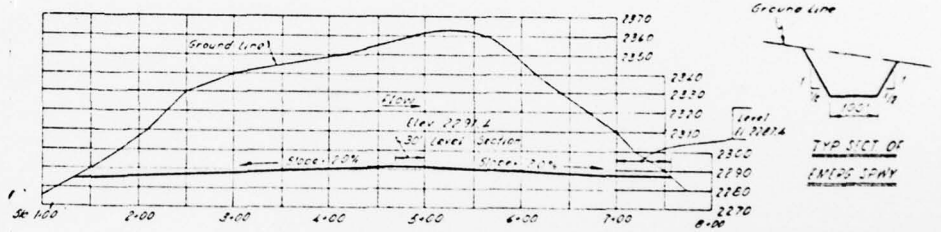
LOWER NORTH RIVER WATERSHED
CUTOFF TRENCH DETAILS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PLATE 2



TYPICAL SECTION OF DAM

EARTH FILL REQUIREMENTS

1	With Bentonite	Same	—	—	—	—	—	→
2		A	100%		6"	3"	—	C
3		A	100%		18"	24"	—	C
4					18"	3"	—	C



PROFILE & EMERGENCY SPILLWAY

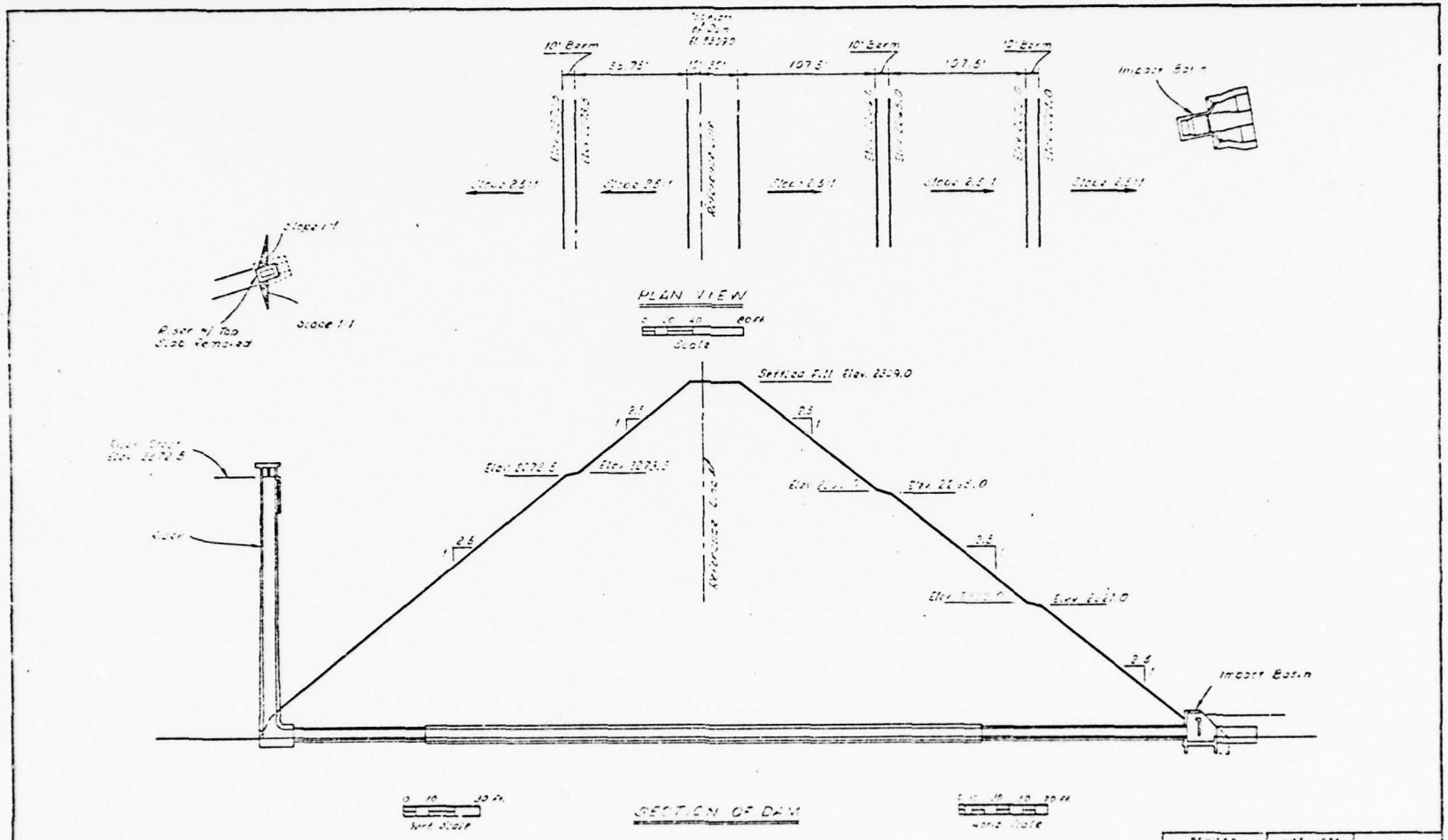
LOWER NORTH RIVER WATERSHED
OF THE POTOMAC RIVER BASIN WATERSHED PROJECT
FLOODWATER RETARDING DAM NO. 6
AUGUSTA AND ROCKINGHAM COUNTIES, VIRGINIA

FILL PLACEMENT & SPILLWAY EXCAVATION

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 3

VA-534-P



REVISED JUNE 1974

LOWER NORTH RIVER WATERSHED
OF THE BUCKHORN BRANCH PROJECT
FLOOD WATER RETARDING DAM NO. 5
AUGUSTA AND ROCKINGHAM COUNTIES, VIRGINIA

PRINCIPAL SPILLWAY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 4

VA-534-P

APPENDIX II

PHOTOGRAPHS

CONTENTS

Note: Photographs were taken 14 June 1978.

NAME OF DAM: LOWER NORTH RIVER NO. 81C

PHOTO 1

PHOTO 2

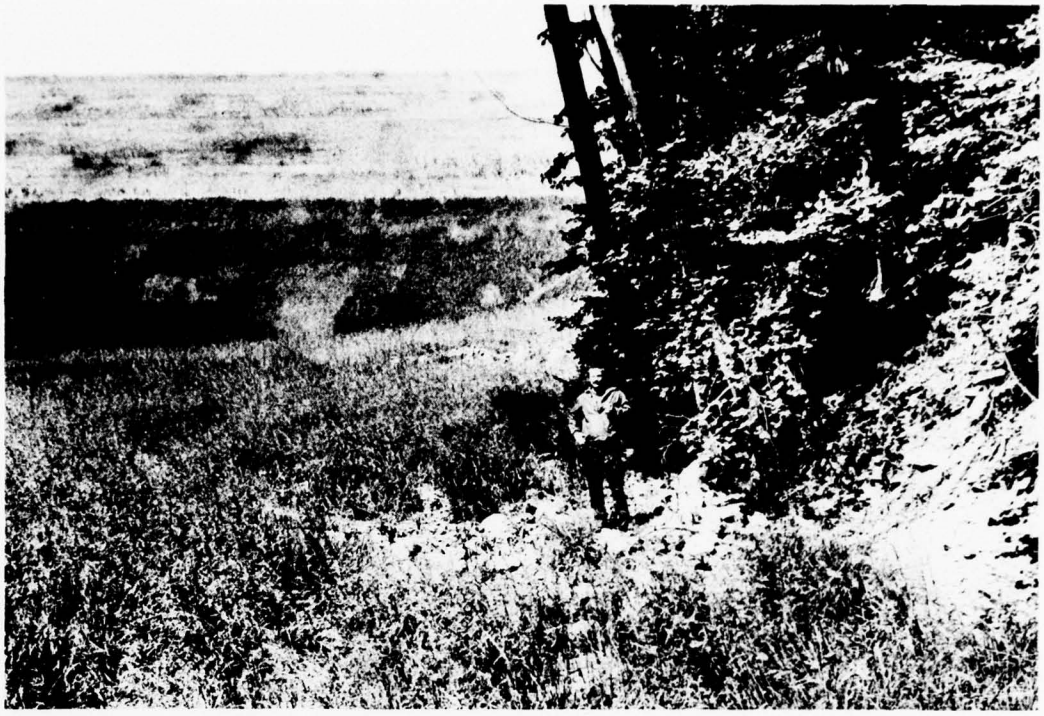


PHOTO 3

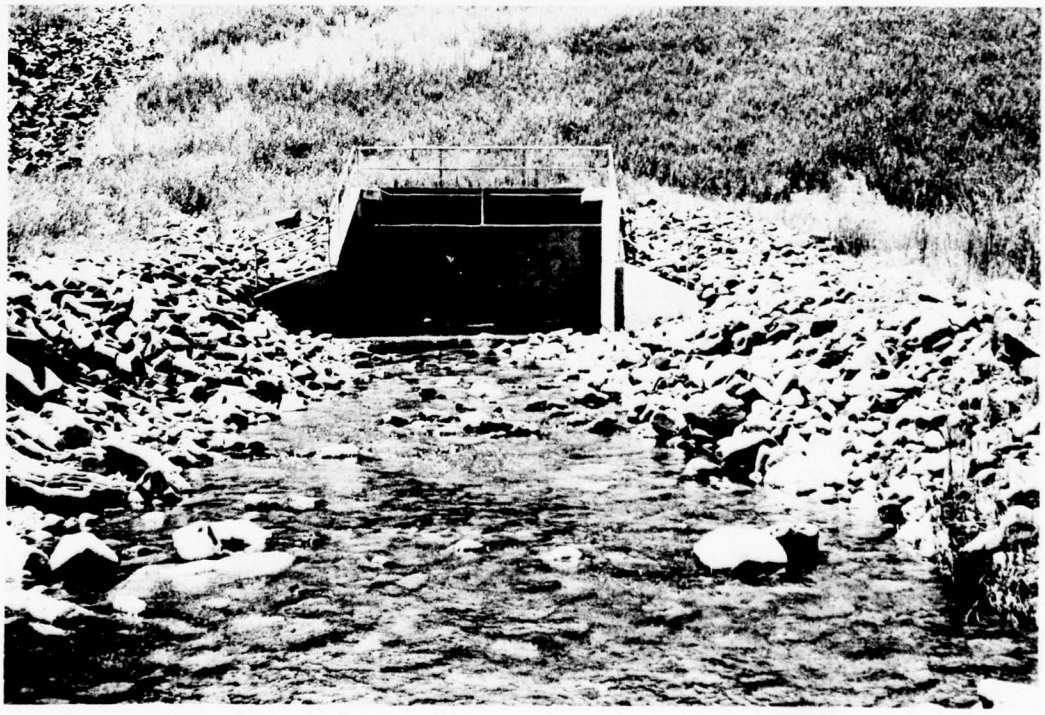


PHOTO 4

APPENDIX III

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name Dam Lower North River No. 81C (Switzer Dam) County Rockingham State Virginia Coordinates Lat. 3834.2 Long. 7908.2

Date Inspection 14 June 1978 Weather Clear, sunny Temperature 78°F.

Pool Elevation at Time of Inspection 2273.0 M.S.L. Tailwater at Time of Inspection 2168.9 M.S.L.

III-1

Inspection Personnel:

MICHAEL BAKER, JR., INC.:

D. J. Greenwood
J. M. Thompson
W. L. Sheafer

VIRGINIA WATER CONTROL BOARD:

Mac Sterrit

D. J. Greenwood Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracking was found during our field inspection of the top, upstream and downstream faces of the embankment	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	There was no visible movement or cracking beyond the toe of the embankment. The area beyond the toe is smoothly graded and well-seeded.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	The embankment and abutment slopes are generally well seeded with very little erosion and no sloughing. Small portions of the downstream embankment have very little topsoil cover and are sparcely vegetated. Four inch deep tire track depressions are noticeable along the downstream bench where water is ponding.	The sparce vegetation areas on the embankment should be reseeded. The tire depressions should be filled and reseeded.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The alignment of the crest is good with no unusual irregularities in the vertical or horizontal directions.	
RIPRAP FAILURES	The embankment riprap appears to be functioning as designed and appears to be acceptably placed and adequately designed. There is no noticable erosion around the riprap.	

EMBANKMENT

LOWER NORTH RIVER NO. 81C

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONSTRUCTION MATERIAL	Dry to damp brown dense silt, sand, gravel and rock fragments in variable percentages were observed in different areas on the surface of the dam. The dam was designed to be constructed with four zones of earth fill including an impervious zone with bentonite.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The junctions of the embankment to the abutments have been well seeded and riprapped where required for surface drainage. There is no visual cracking or movement. The junction of the spillway and the dam is in sandstone and siltstone through which the spillway is cut.	
ANY NOTICEABLE SEEPAGE	Several clear seeps with a flow of <1 g.p.m. were observed on the lower bench on the downstream slope. Seepage between the outlet of the principal spillway and the dam abutment was measured at 0.75 g.p.m. (Photo 4). The outlet flow of the old stream located 150 feet from the toe of the dam on the left side was determined to be 0.7 g.p.m. (Photo 3) into a channel with rocks. A small wet area is located at the downstream toe of dam on right near old stream. A six inch diameter hole was found about 30 feet downstream from the toe of the dam and at about centerline of the dam. The hole does not appear to be an animal borrow. There was also a noticeable reddish staining of the earth in this area along the drainage path, suggesting water flows from this hole. At the time of our inspection, no water was present.	The clear seepage is not considered to be serious, but it should be inspected periodical to determine if it is increasi or if erosion is developing. This hole should be observed during high flow periods to determine if it represents any possible piping of the soil.
STAFF GAGE AND RECORDER	The City of Harrisonburg has installed a wooden staff gage on the riser tower. The board is used by the city to compute available storage.	
DRAINS	None were observed.	

Lower North River No. 81C

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	The foundation is on red and gray hard, fine grained sandstone with some siltstone. The attitude of the strata was observed to vary from horizontal to wavy with some cross beeding in the emergency spillway. Joints and fractures are prevalent.	

Lower North River No. 81C

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	There are none.	
APPROACH CHANNEL	The approach channel to the emergency spillway is primarily rock-cut with some compacted fill with very little vegetation and on an adverse two percent slope. The bottom width is about 100 feet with 0.5:1 side slopes forming a trapezoidal shape. The bedrock consists of jointed hard sandstone and medium siltstone. See See Photo 1.	
DISCHARGE CHANNEL	The discharge channel is cut in primarily sandstone and siltstone with trapazoidal shape 100 feet wide and on a positive two percent slope. The channel banks are riprapped where bedrock is absent. The channel discharges along a small water course on the left abutment with an adjacnet road (see Photo 1).	
BRIDGE AND PIERS	There are none.	
CUT SLOPES	Red and gray hard sandstone with some medium hard siltstone and thin soft clay shale seams were observed in the cut slopes. The bedding planes vary from a horizontal to 7° undulating dip. There are two sets of steep to vertical joint systems. The cut slopes on both sides were made at a 0.5:1 ratio and appear to be stable with minor amounts of small rock talus. See Photos 1 and 2.	

Lower North River No. 81C

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit concrete surfaces are in very good condition. The outlet structure concrete walls, concrete floors, grating and railing are also in very good condition.	
INTAKE STRUCTURE	The intake structure is a standard S.C.S. fixed crest concrete riser. The intake structure also has five hand-operated water control gates including a 42" lake drain. The gates are operated by the city several times during the year. The pool level was about three or four feet below the top of the structure.	
OUTLET STRUCTURE	The outlet structure is an energy dissipator located immediately downstream of the outlet pipe and physically located at the downstream right toe of the dam. The channel adjacent to the dissipator is riprapped. See Photo 4.	
OUTLET CHANNEL	The outlet channel is a regular trapazoidal shape with riprap banks. The riprap appears to be adequately sized and well placed. There are no obstructions or measurable amounts of debris in the channel. See Photo 4.	
EMERGENCY GATE	The emergency gate is a 42" slide gate operated by a hand power mechanical lift located on the inlet tower platform. The lift is new and in good condition.	

Lower North River No. 81C INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	There are none.	
OBSERVATION WELLS	There are none.	
WEIRS	There are none.	
PIEZOMETERS	There are none.	

Lower North River No. 81C

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are well vegetated and steep. There were no visible erosion problems or sloughing. The area is located in a National Forest, consequently, is thickly wooded and natural.	
SEDIMENTATION	The dam was completed in 1975, consequently, has no appreciable sedimentation.	

Lower North River No. 81C

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is adequate with rocks in the streambed.	
SLOPES	The slopes of the banks are stable with riprap protection in the vicinity of the outlet.	
APPROXIMATE NO. OF HOMES AND POPULATION	Rawley Springs which is located approximately eight miles downstream on the Skidmore Fork of the Dry River has an estimated population of 100 with 50 structures.	

APPENDIX IV

CHECK LIST - ENGINEERING DATA

Lower North River No. 81C

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	A complete set of as-built plans are available at the Norfolk District of the Corps of Engineers. A plan view of the dam is included in this report as Plate 1.
REGIONAL VICINITY MAP	The map on the title sheet for the as-built plans was used as a vicinity map and is attached as the Location Plan.
CONSTRUCTION HISTORY	The foundation investigation was done in 1966 and 1971. The dam was designed by the S.C.S. in 1974 and constructed by English Construction Company in 1975.
TYPICAL SECTIONS OF DAM	Typical section of the dam is enclosed in the Phase I Inspection Report as Plate 3.
HYDROLOGIC/HYDRAULIC DATA	Hydrologic and hydraulic design data is available at the Norfolk District of the Corps of Engineers.
OUTLETS - PLAN and - DETAILS	are available at the Norfolk District of the Corps of Engineers.
- CONSTRAINTS and - DISCHARGE RATINGS	are included in the S.C.S. design calculations and are available at the Norfolk District of the Corps of Engineers.
RAINFALL/RESERVOIR RECORDS	No rainfall or reservoir level records are available at the dam. Rainfall data is available from Virginia Climatological Records.

Lower North River No. 81C

ITEM	REMARKS
DESIGN REPORTS	Design calculations by the S.C.S. are available at the Norfolk District of the Corps of Engineers. No contract specifications were available.
GEOLOGY REPORTS	A subsurface investigation consisting of test pits and test borings are part of the design documents. Geology Reports are available and are enclosed in Appendix VI.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Design computations were done by the S.C.S. for hydrology and hydraulics. Stability Calculations are available and are enclosed in Appendix VII.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	A foundation and borrow investigation was performed with test borings and test pits. Constant head borehole permeability tests and pressure testing was done in the borings.
POST-CONSTRUCTION SURVEYS OF DAM	The dam is inspected yearly by the S.C.S. District Conservationist. Copies of these inspection reports are attached to this report.
BORROW SOURCES	The as-built drawings show the borrow sources.

Lower North River No. 81C

ITEM	REMARKS
MONITORING SYSTEMS	No monitoring system other than the spillway riser was designed into the dam.
MODIFICATIONS	No known modifications have been made other than repairing erosion and reseeding.
HIGH POOL RECORDS	No high water records are available.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Yearly inspections are made by the District Conservationist of the S.C.S. No known major construction has been done since the dam was built.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	Yearly inspections are made by the S.C.S. Erosion repair and reseeding has been done.

Lower North River No. 81C

ITEM		REMARKS
SPILLWAY PLAN		Sections and details of the ungated, earthen overflow spillway are enclosed as Plates 3 and 4.
	SECTIONS	The section measured in field closely matches that on plans 100' wide and approximately the same slopes.
	DETAILS	Earth with minimal growth.
OPERATING EQUIPMENT PLANS & DETAILS		Crank operated lifts with pedestal bases were used. Plans and details are available at the S.C.S. Richmond Office.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 14.7 square miles of heavily forested and undeveloped land

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 2272.5 (4852 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 2291.4 (7367 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 2298.7 (7150 acre-feet)

ELEVATION TOP DAM: 2309.0 (7778 acre-feet)

CREST: Emergency Spillway

a. Elevation 2291.4
b. Type Rock-cut trapezoidal uncontrolled discharge channel
c. Width 100 feet at base with 0.5:1 sides
d. Length 720 feet
e. Location Spillover Left abutment
f. Number and Type of Gates None

OUTLET WORKS: Principal spillway riser

a. Type Standard fixed crest riser pipe with control gates
b. Location Rt. upstream corner of the dam and rt. downstream at base
c. Entrance inverts 2170 emergency gate, 2272.5 fixed crest
d. Exit inverts 2168.7
e. Emergency draindown facilities 42 inch drain, lift operated

HYDROMETEOROLOGICAL GAGES: None at site

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

APPENDIX V

ANNUAL MAINTENANCE INSPECTION REPORT

S... OAH VALLEY SOIL AND WATER CONSERVATION DISTRICT

Report of Annual Maintenance Inspection of Watershed Dams in

LOWER NORTH RIVER WATERSHED PROGRAM

April 12, 1978

An inspection was made on 5 dam sites in Lower North River Watershed. Those present on the inspection were:

Gerald Fawley	Chairman District Board
James Moyers	Chairman Watershed Committee
Arlis Frymyer	District Director
John Crist	Soil and Water Conservation Commission
Don Parslow	U.S. Forest Service
Randy Maupin	Soil Conservation Service

The following observaions were made by members of the inspection party.

Site No.	Date Completed	Date of last Inspection	Remarks
22 B	4-67	4-23-77	Additional rail or large stone needed to control traffic in borrow area above spilway where new guard rails were placed. Work reported needed in Borrow Area C has not been completed.
81 C	10-75	-	Site in good condition. Suggest top of dam be fertilized at regular intervals to maintain grass stands.
80	3-67	4-20-77	Repairs needed on path that has been worn to waters edge on wet side of dam.
83	4-65	4-20-77	Vehicle traffic has worn off vegetation in several areas. No repair needed at this time.
78	11-65	4-20-77	Trash rack needs repair. Bolts broken that hold steel bars in place. Vegetation has been worn off by vehicle traffic in several areas but repairs not suggested at this time.

APPENDIX VI

GEOLOGIC REPORT

Sheet 1 of 2
VA-534-G
12-69

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

1 A Section - 1

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES
Supplemental
GENERAL

State Virginia County Rockingham ; -- ¼, -- ¼, Sec. --, T -- R --; Watershed Lower North River
Subwatershed Skidmore Fork Fund class FP (FP-2, WP-1, etc.) Site number 81-C Site group 1 Structure class C

Investigated by T. Mack, Geologist (signature and title), Equipment used Sprague & Henwood 40C Drills International Backhoe - International TD 14 dozer (Type, size, make, model, etc.) Date 12/71 - 2/72

SITE DATA

Drainage area size 15.69 sq. mi., 10,040 acres. Type of structure Earth Fill Purpose Flood prevention & water supply

Direction of valley trend (downstream) NE Maximum height of fill 140± feet. Length of fill 1460 feet.

Estimated volume of compacted fill required 2,000,000 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	--	--	--
Floodwater	--	--	--

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Ridge & valley province. Topography mountainous. Attitude of beds: Dip 13° NW Strike N 87° W

Steepness of abutments: Left 33 percent; Right 68 percent. Width of floodplain at centerline of dam 850 feet

General geology of site:

The height of embankment fill was raised from 86.6 feet to approximately 140.0 feet. Due to this increase, additional drilling was done in the foundation area. Here six holes were emplaced. These drill holes are numbered DH 321, DH 341, and DH 521 through DH 524. Five additional drill holes were emplaced in the proposed emergency spillways. These holes are numbered DH 21 and DH 22 and DH 241 through DH 243. To measure the thickness of the silty bench material in borrow area C, four drill holes were used. These are numbered DH 101-B through DH 104-B.

USDA-SCS-HYATTSVILLE, MD. 1969

As there was need for additional coarse-grained borrow material, 12 test pits were dug in the floodplain. These are numbered DH 150-A through DH 161-A. An additional 20 test pits were emplaced on the abutments both upstream and downstream from the centerline of the dam. These abutment test pits generally showed shallow residual and colluvial soils that in some areas were underlain by red siltstone.

Samples of weathered shale occurring on U. S. Route 33 at Brandywine, West Virginia and Raleigh Springs, Virginia were sent to the laboratory at Lincoln.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-376C
REV. 2-64
SHEET 1 OF 3
VA-534-G

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
Lower North River	Skidmore Fork	Rockingham	Virginia

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
81-C	1	C		12/71 - 2/72

FOR IN-SERVICE USE ONLY

INTERPRETATIONS AND CONCLUSIONS

1. Two proposed emergency spillways were investigated. One drill hole, DH 21, was placed in the proposed cut on the right abutment. Four drill holes, DH 22 and DH 241 through DH 243, were placed in the proposed cut on the left abutment.

The cut on the right abutment will entail less rock removal as the cut is here placed on a ridge. This cut on the right abutment is suggested to be used. Concern was expressed over the fact that in this cut the dip of the strata (13^{o}) is away from the backslope. However, this factor will not matter as the Hampshire sandstone and siltstone here is more influenced by secondary features than the primary features. This is true of sandstones and limestones of the Appalachian Ridge and Valley province.

Thus the 90 degree fracture pattern that has two fracture planes vertical and the third approximately horizontal would influence the slope stability of the backslope more than the bedding of the strata. The nature in which the bedding would influence the slope stability of the backslope is the fact that near horizontal fracture plane tends to follow the primary bedding plane. The two vertical fracture planes would tend to influence the stability of the backslope more than the near horizontal fracture plane.

2. Fine-grained borrow material present on the site to construct the core and cutoff is scarce. This statement is made not knowing the design of the embankment, but the designers can adapt the design to the lack of fine-grained plastic borrow material.

Use can be made of the weathered siltstone on the abutment downstream from borrow area C.

At present estimate at least 450,000 yards of fine-grained material is present in borrow areas B, C, D, E and F. This conclusion assumes that all factors will be ideal to obtain borrow.

These ideal assumptions include:

a. That borrow can be pulled to the depth as shown in seismic surveys in borrow areas B and D where no

backhoe refusal was had. These seismic surveys show depths to rock ranging from 15.5 feet to 29.6 feet in borrow area B. Depths as determined by seismic in borrow area D range from 9.2 to at least 25 feet. If all of this material related to these seismic depths can be used, then an excess of 450,000 yards can be realized. As no water tables are known below the reach of the backhoe, wet borrow could be a problem.

b. In borrow area C a layer of cobbly material was determined from drill information to be present below 20.0 feet. To have the estimated amount of borrow, all of the five acres in borrow area C would have to be utilized to a depth of at least 20 feet. This is despite the fact that many areas of cobbles exist as pockets of GM material that range up to 78 percent estimated +4.

c. To obtain the estimated quantity of fine-grained borrow material, use will have to be made of material that contains cobbles and gravels. This will entail expanding the existing fine-grained borrow areas into the cobbly areas that lie at lower elevations. As the transition between the fine-grained plastic material and the cobbles is generally gradual, cobbles can be incorporated into the core with the fine-grained material.

Almost all Appalachian dam sites have been lacking in fine-grained borrow material. Both the geologic report and the plans have overestimated the fine-grained material present.

Reasons for this high estimate of material are:

a. In excavating material, at least one foot and often one and one half feet of soil is stripped off the surface in topsoil stripping. This is due to the depth of the tree roots and the irregularities of the ground surface. Also above top of rock irregularities of the rock surface necessitate leaving borrow in pockets below the rock spines. These factors can often cause two feet less borrow to be excavated than was calculated to be present.

b. Wastage and shrinkage cause losses. Often contractors will build haul roads out of scarce fine-grained material.

c. The water table rising can render borrow useless.

3. The sandstone occurring in the two proposed emergency spillway cuts is unweathered and unfractured at the approximate elevation of the proposed bottoms of the cuts.

The sandstone and siltstone in the drill holes placed in the proposed cuts can be ripped to certain estimated depths. Tentative estimates of the rippability depths in the drill holes in the emergency spillway are listed as:

	Rippable	Marginal Rippable
DH 21	6.5-28.0	28.0-31.0
DH 22	7.7-27.0	27.0-29.0
DH 241	3.0-24.5	24.5-52.0
DH 242	16.5-20.0	20.0-40.0
DH 243	2.2-20.0	20.0-32.0

4. After the raising of the dam to 140 feet, finding additional borrow becomes a problem. Scant material was found to be present upstream from the dam centerline. Some area of SM was found to occur two miles upstream from the dam.

An area of residual soil on a fairly gentle slope downstream from borrow area C was found to be underlain by weathered red siltstone. This siltstone could be ripped out and used as poor grade fine-grained material by breaking up and compacting with a sheeps foot roller.

It is hoped that no borrow material will have to be trucked into the site. However, weathered shale samples from the Brallier shale from Brandywine and Raleigh Springs were submitted to the laboratory in Lincoln.

APPENDIX VII

STABILITY ANALYSES

SCS-ENG-351
REV. 7-71

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE: LOWER NORTH RIVER #81-C VIRGINIA

DATE: 3-22-72

METHOD OF ANALYSIS: BLOCK & SWEDISH CIRCLE

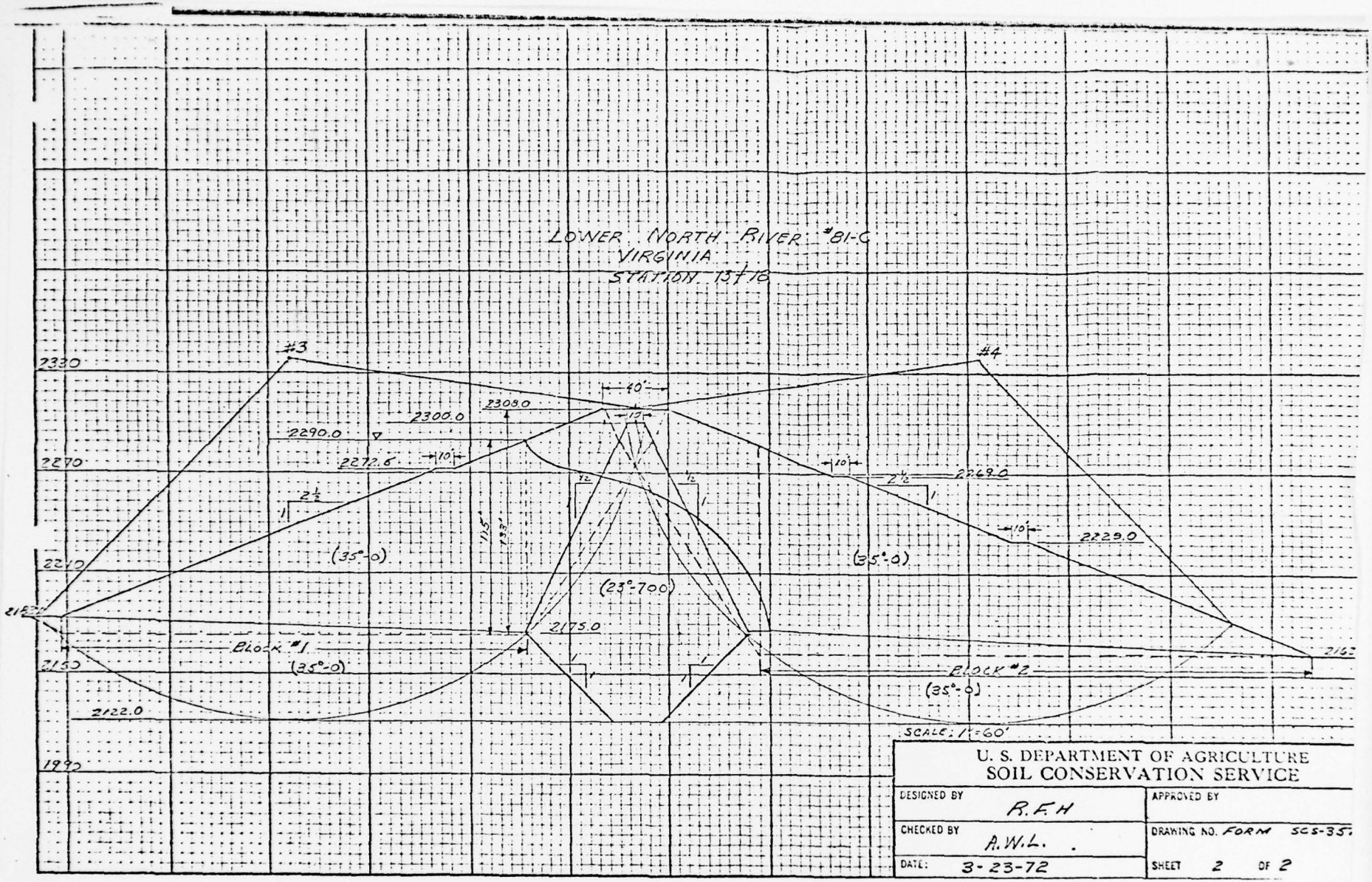
ANALYZED AT: S.M.L.

APPROVED BY: JO

SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA						REMARKS
		γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg.)	tan ϕ	c (psf)	
① EMBANKMENT		125.5	139.5	141.5	79.0	23	.424	700	
② EMB. & FOUND.			125.0	135.0	72.5	35	.700	0	
③									
④									
⑤									
⑥									
⑦									
⑧									

TRIAL NO.	SLOPE	CONDITIONS	F_s
		SECTION AT STATION 13+18	
		ZONED EMBANKMENT: SHELL (35-0), C_{OEE}=(23-700)	
		FOUNDATION: (35-0)	
		UPSTREAM: 10' BERM @ 2272.5, FULL DRAWDOWN	
		DOWNSTREAM: 10' BERMS @ 2269.0 & 2229, DRAIN @ TOE OF C_{OEE}, STEADY SEEPAGE	
1 UP	2½:1	BLOCK ANALYSIS	1.32
2 DN	2½:1	BLOCK ANALYSIS	2.0
2A DN	2½:1	SAME ANALYS AS #2 WITH 0.15g EARTHQUAKE	1.48
3 UP	2½:1	COMPUTER ANALYSIS (ICES) SWEDISH CIRCLE	1.45
3A UP	2½:1	" " BISHOP	1.71
4 DN	2½:1	" " SWEDISH CIRCLE	2.2
4A DN	2½:1	" " BISHOP	2.7

Sheet 1 of 2



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DESIGNED BY R.F.H	APPROVED BY
CHECKED BY A.W.L.	DRAWING NO. FORM SCS-35
DATE: 3-23-72	SHEET 2 OF 2